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Alliance block composition patterns in the microelectronics industry

Citation for published version (APA):

Duysters, G. M., & Lemmens, C. E. A. V. (2008). *Alliance block composition patterns in the microelectronics industry*. UNU-MERIT, Maastricht Economic and Social Research and Training Centre on Innovation and Technology. UNU-MERIT Working Papers No. 060

Document status and date:
Published: 01/01/2008

Document Version:
Publisher's PDF, also known as Version of record

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

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Working Paper Series

#2008-060

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20 oktober 2008

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ABSTRACT

In this note we examine whether a position in a technology alliance block is accessible to everyone. It appears that partners are selected on the basis of distinctive attributes they have, which can inhibit outsiders to join these alliance groups. Our findings clearly indicate that alliance blocks are composed of actors that have rather similar characteristics. The social selection processes that alliance block members employ vis-à-vis non-block members can create a source of competitive advantage in terms of a higher innovative performance. Empirical research is focused on the international microelectronics industry.

Key words: strategic technology alliances, alliance block membership strategy, microelectronics industry, group-based competition

Jel Codes: O31, O32

UNU-MERIT Working Papers
ISSN 1871-9872

Maastricht Economic and social Research and training centre on Innovation and Technology, UNU-MERIT

UNU-MERIT Working Papers intend to disseminate preliminary results of research carried out at the Centre to stimulate discussion on the issues raised.

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We thank Victor Gilsing for his suggestions and comments on an earlier version of this paper.

INTRODUCTION

Over the past decades we have witnessed a tremendous growth in the number of strategic technology alliances in high-tech sectors. These collaborative agreements are often used in order to reduce costs of R&D, to improve innovative performance, to reduce time-to-market or to search for new technological opportunities (for a more elaborate overview, see e.g. Hagedoorn 1993). They are increasingly considered to be efficient vehicles for external knowledge acquisition (see e.g. Duysters and Hagedoorn 2000). As firms get more and more connected through collaborative agreements, they become embedded in inter-organizational networks of strategic alliances (Granovetter 1992; Gulati 1998). This has led to a new form of technology competition: group-based competition, which is characterized by closely connected groups of strategic alliances that compete against other alliance groups or with traditional independent firms (Gomes-Casseres 1996; Guidice et al. 2003; Das and Teng 2002). An alliance block consists of a group of multiple-partner firms that are linked to each other through strategic alliances. The driving forces behind the formation of these technology-driven alliance blocks (1) or alliance constellations (Gomes-Casseres 1996) are typically related to joint innovative efforts. Within these densely tied alliance blocks, firms are able to capture the full benefit of their innovative activity as they benefit from knowledge spillovers and network externalities. An alliance block constitutes a learning environment that is based on trust that stimulates knowledge transfer and innovation. In an empirical study of Duysters, Hagedoorn and Lemmens (2004) it turned out that members of alliance blocks are indeed more productive in their joint innovative efforts than non-block members. It seems that innovation in alliance blocks is a resourceful strategy; but is an alliance block membership strategy accessible to everyone? The academic literature is not clear on this issue. It overlooks how the composition of the group based on certain traits of the members can inhibit outsiders to join.

In this note, we would like to explore whether alliance blocks are 'open' in the sense that firms with various different characteristics and backgrounds can participate, or whether these groups are carefully crafted groups, which are selected on the basis of specific attributes. There is strong evidence (Duysters and Lemmens 2003) that social selection processes like lock-out mechanisms play a role in the formation of alliance groups. Powerful alliance block members – those with a central position- may favor those firms that contribute most to the innovative capabilities of the group as a whole. Hence, it is interesting to study the traits of the members of alliance blocks. The specific traits of block members and the social selection processes they employ can create a source of competitive advantage in terms of innovative performance (a.o. Duysters, Hagedoorn and Lemmens 2004). Apparently, a careful composition of the alliance block enables block members to innovatively outperform their non-group counterparts. From the literature we derive certain attributes that can explain the differences in innovative capacity between alliance block members and their non-group counterparts. We will adopt a social network perspective (Nohria 1992; Gulati 1998) to highlight the social selection processes that stem from trust-based governance: replicating alliances with similar and trustworthy partners.

This note is a descriptive study, based on making an inventory of traits of members of alliance blocks. We do not aim to address the causal relationship among innovative performance, alliance block membership and the specific attributes of the members. Instead we are specifically interested in the composition of the group. For this purpose we will perform an empirical analysis using discriminant function analysis (2).

HYPOTHESES

The focus of research on alliance blocks is rather limited and relatively scarce. It has focused merely on managerial issues regarding the coordination of alliance groups or multilateral alliances (Doz and Hamel 1998; Das and Teng 2002) or on the various characteristics of alliance groups, such as size and composition of groups in terms of internal network structures (Gomes-Casseres 1994, 1996; Nohria and Garcia-Pont 1991). Another stream of research has addressed the competitive dynamics of alliance blocks (Gomes-Casseres 1994; Silverman and Baum 2002; Guidice et al. 2002). An additional body of literature addresses alliance block membership as an alliance network positioning examining the effects of relational and structural embeddedness on company performance (see e.g., Rowley et al. 2000). From this perspective, alliance block membership can be seen as one of the strongest forms of social embeddedness. It is comparable to Coleman's notion of network 'closure'. Coleman (1988) argues that being part of a dense network -like an alliance group- is advantageous since it involves trust and cooperation among its members. Alliance blocks are bound together by multiple and relatively strong ties (Vanhaverbeke and Noorderhaven 2001). These strong ties foster knowledge transfer and innovative activity.

In order to understand the rationale of alliance block membership, we have to take an approach that addresses the interaction between firm resources and capabilities in a strategic context of collaboration and competition (Henderson and Mitchell 1997; Sakakibara 2002). Then, under these circumstances of collaboration and competition in networks, the network is the locus of innovation and organizational learning (Sakakibara 2002). As opposed to static approaches like the resource-based view (Dyer and Singh, 1998), one of the most promising approaches that takes on a network dynamic perspective is the strategic behaviorial theory (Kogut 1988). This approach argues that firms act in order to improve the competitive position vis-à-vis their rivals as this position influences the asset value of the firm (Kogut 1988). In this view, collective collaborative agreements, like alliance blocks, are placed in the context of competitive rivalry. Through the strong ties in their group, block members actually have direct access to the knowledge bases of their group members. In such a context characterized by strong ties and familiarity, firms in alliance groups tends to generate higher innovative performance, than those pursuing an innovation strategy outside of an alliance group (Duysters et al. 2004).

Power in the alliance network

These technology-driven groups in the network compete for specific partners and distinct technologies in order to differentiate their competencies from their competitors. In fact, these alliance blocks often operate as powerful oligopolistic sub-networks that engage in group-based competition. Since alliance block members are multiple-partner firms with many direct links to other group members, implies they have a central position in the network, i.e. they have a high 'degree centrality' (Freeman 1979). As these block members occupy central positions in the network, as a result of the many direct links they employ, they tend to be powerful players in the network. They are powerful in the sense that they have access to a large stock of potential information sources. Network centrality or degree centrality implies benefits regarding access to critical resources, which are required to strengthen the competing technology blocks. Furthermore, network centrality is an important indicator of social capital as it enables block members to get access to information about potential partners (Gulati et al. 1999). Central players are also more visible in the network than less central players. This enhances their attractiveness to other players as it signals the firm's engagement in cooperative agreements and hence can indicate willingness, experience and ability in strategic partnering. When firms intend to enhance their own visibility and attractiveness as potential partners they have a tendency to look for central partners (Gulati and Gargiulo 1999) in the network. As the partners with a prominent network position are found to be attractive partners (Gulati and Gargiulo 1999), this central position in the network is thus positively related to the rate of new linkage formation (Tsai 2000).

Central partners also have the power to lockout potential partners from their alliance blocks. Alliance block members can preclude partners to ally with firms that are in peripheral parts of the network. These lock out effects are thus caused by the implicit expectation of loyalty amongst group members (Gulati et al. 2000). In this sense these central players can ballot on non-group member's admission to the alliance block. An empirical study on this lock-out phenomenon (Duysters and Lemmens 2003) showed strong indications for these specific lock out effects. In this study it appeared that the number of group members in the network remained relatively stable over time, whereas at the same time the number of actors in the network increased. A possible explanation for this can be that non-block members or other peripheral players may have little to offer and hence may add little to the central players' attractiveness. From this we can conclude that a distinguishing attribute of alliance block members is the central position they occupy in the network from which they derive power in the network. Hence, we expect that centrality in the network is a discriminating attribute between alliance block members and non-block members.

In similar vein, powerful central firms in the network not only derive their power and reputation from their central position, but also from their size. Then, size of firms can affect the rate of R&D collaboration. There are some indications in the literature that larger companies have a higher propensity to engage in partnerships than smaller companies (Duysters and Hagedoorn 1995; Mytelka 1991), which could explain their participation in alliance blocks. Alliance block members might be able to ballot on non-group members' admission to the alliance block, based on the power they derive from their size and central position in the network Therefore, we expect that alliance block members are not only central players in the network; they are often also key-players in alliance blocks based on their size.

H1: Alliance block members are larger in size than non-alliance block members

H2: Alliance block members have more central positions in the network than non-alliance block members

The technological knowledge base

Firms with better R&D capabilities tend to have a higher rate of participation in R&D collaborations. A cross-sectional study on high-tech industries showed that R&D intensive firms tend to form more R&D consortia (Sakakibara 2002), which could explain their participation in alliance blocks. Through R&D collaboration in alliance groups, innovators benefit through spillovers and externalities in these blocks, which enables them to share the costs and revenues of R&D projects. This can serve as an incentive to conduct further R&D (Sakakibara 2002).

Alliance groups are basically technology-driven. Differences in performance among competing alliance groups can be due to the nature of the technological knowledge they possess and their ability to exploit that knowledge (Steensma and Corley 2000). Then, engaging in multiple alliances enables firms to transfer knowledge and replenish their knowledge bases (Mowery et al. 1996; Kogut 1988). In this way, these firms can internalize the competencies of partners to create next-generation competencies (Hamel 1991; Sakakabira 2002). Alliance groups derive their competitive advantage from their superior and particular technologies, which they develop and exploit together in the alliance blocks. As a result of their technological (re) positioning strategies, we witness technological standard battles among alliance groups and independent firms (Gomes-Casseres 1996; Das and Teng 2002). Since firms within those alliance groups complement and build on each other's specific technologies, we expect that these alliance block members can reach critical mass in terms of economies of scale and scope through their technological specialization in groups. Therefore it seems that companies, which have a higher technological specialization, will be more innovative, than firms that are less specialized. This makes them particularly attractive team members. The technological knowledge base in terms of specialization and R&D intensity therefore seems to be the glue that holds alliances blocks together when it comes to selecting partners. Therefore we hypothesize:

H3: Alliance block members are more specialized in terms of their technology profiles than non-alliance block members

H4: Alliance block members are have higher R&D intensities than non-alliance block members

DATA AND METHODOLOGY

Our empirical analysis covers the industrial, technological and networking activity of companies operating in the international microelectronics industry. This industry has been technology-driven throughout its history, which indicates that technology positioning strategies and technology competition are keys to survival (Podolny and Stuart 1995; Stuart and Podolny 2000). It is an industry where one finds a large number of strategic technology alliances that play an important role in the competitive strategies of companies (see amongst others, Duysters and Hagedoorn 1998; Gomes-Casseres 1996; Hagedoorn and Schakenraad 1992; Mytelka 1991). It is well documented that alliances are an important element of the technology acquisition strategies of companies in these high-tech sectors (e.g., Stuart and Podolny 1996, 2000; Hobday 1997; Langlois and Steinmüller 2000; Vanhaverbeke et al. 2002; Rowley et al. 2000; Holbrook et al. 2000; Stoelhorst 2002; Park et al. 2002; West 2002). Although technology alliances may also play a role in other sectors, the relation between network positioning or alliance block membership on technological performance is probably most evident in high-tech sectors such as the microelectronics industry. Furthermore, this industry can be seen as the driving force of technological change in virtually all sectors of the information technology industry. Its outputs are vital components in a wide range of other products in related industries such as computers, systems and peripherals (Jelinek and Schoonhoven 1990). Finally, the industry has a high propensity to patent, especially in the period of our study. This allows us to track the innovative capacity of the companies in our sample by means of their patent activity. The sector and its companies are very well documented in terms of available company information and sectoral data.

Our analysis refers to a group of 138 companies taken from the MERIT-CATI database (see appendix for a description), which have 5 or more alliances during the period 1980-2000 and are dominantly present in the international microelectronics industry. By calculating the degree centralities in UCINET over the period 1980-2000, we found 138 companies who had 5 alliances or more in this period. The degree of an actor (company) is equal to the total number of direct links of a particular actor to other actors. The total number of strategic alliances in the sample was 2,864. Because we did not have patent data available for 3 companies, we worked with a sample of 135 companies, of which 68 are American, 35 are European, and 32 Asian.

In line with Duysters and Hagedoorn (2001), we perform a discriminant analysis (3) to address the specific characteristics of alliance block members in order to indicate how block members differ significantly from non-block members regarding these specific attributes or variables.

We operationalize the construct of power to ballot admission in groups (H1 and H2) by looking at the size of the firm and a central position in the alliance network.

- A central position is indicated by the measure 'degree centrality' (Freeman, 1979) (CENTRALITY) (6) by calculating the firms' total number of direct links to other actors.
- Size (SIZE) is measured in terms of revenues; which roughly equals turnover as an indicator of economic magnitude (Duysters and Hagedoorn, 1995).

The construct of the technological knowledge base or technology strategy that influences the partner selection process (H3 and H4) is operationalized by investigating the firm's propensity to apply for patents, its R&D intensity and its technological specialization. We expect a positive effect of R&D intensity on patent activity, as these research efforts will (at least partly) be transformed into patents (Hagedoorn, Duysters 2002).

- The variable PATENT indicates the number of patents firms apply for in the microelectronics sector during the period 1983-2000.
- R&D intensity (RDINTENSITY) is operationalized by calculating the ratio of microelectronics-related R&D expenditures to revenues.
- The variable technological specialization (SPECIALIZATION) indicates the firm's patents applied for in the semiconductor technology classes divided by the total amount of patents applied for in a certain period.
- Alliance block membership (BLOCK) is related to the issue of which firms are actually part of an alliance block. Furthermore we have added the variable home region to see whether home region is a differentiating factor between members and non-members of alliance blocks.
- Concerning home region, we distinguish among three main home regions, i.e. the United States (USA), Europe (EUR), and Asia (ASIA).

Our grouping variable BLOCK MEMBERSHIP can be described as firms that are part of cohesive subgroups in the network. The degree of cohesiveness is dependent on their relative inward (in the group) to outward (outside of the group) interactions (Fershtman 1997; Knoke and Kuklinsky 1982). We use the 'lambda set' measure (4), which fits this idea of comparing in-group ties to out-group ties. Lambda sets represent the line connectivity of subgroup members compared to non-group members. This means that we operationalize alliance block membership by investigating the line connectivity in the group compared to line connectivity outside of the group (5); they measure relative frequency of ties among members compared to non-members (Wasserman and Faust 1994). In our analysis, we measure block membership by calculating lambda sets at the hierarchical clustering level four. We assign a dummy 1 for block members and a dummy 0 for non-block membership.

RESULTS

In order to investigate whether the group means of our grouping variable alliance block membership differ significantly from each other, we perform a T-test study. Table 1 shows that our grouping variable *block membership vs. non-block membership* differs significantly from zero. Table 2 shows the results of the discriminant analysis.

INSERT TABLE 1 AROUND HERE

To determine the most distinguishing variables, we start our examination of companies in the microelectronics industry with an evaluation of the Wilks' Lambda and F-values of the various variables (see Table 2).

INSERT TABLE 2 AROUND HERE

The Wilks' Lambda statistic is concerned with the ratio between within group variance and the total variance. A ratio that is close to one points at an equality of group means, whereas lower values are associated with large differences between the group means. For each variable the F-value is calculated to test the hypothesis that all group means are equal. The results indicate that group means are not equal in the case of *patent applications* (0.784***), *degree centrality* (0.480***), *Asia* (0.951***), *size* (0.864***) and *R&D intensity* (0.985*). This implies a strong rejection of the hypothesis that all group means are equal for these variables and indicates that these attributes differ between alliance block members and non-alliance block members. That is, alliance block members apply for more patents than non-block members (712 vs. 161) (not corrected for firm *size*). Alliance block members occupy positions with a higher *degree centrality* (10.57 vs. 1.4) than non-block members (confirming hypothesis 2).

This implies than alliance block members have on average more direct links (10.57) than non-block members (1.4) and hence occupy more central network positions than non-block members. Furthermore, our results indicate that alliance block members tend to be large firms in terms of their revenues (confirming hypothesis 1) and tend to be R&D intensive (0.15 vs. 0.11) firms. Furhtermore they seem to be based more often in Asia.

The variables *USA*, *Europe* and *specialization* show high Wilks' Lambda values with insignificant results for block members and non-block members; therefore, we cannot reject the hypothesis that the group means for these variables are equal. Therefore we cannot confirm hypothesis 3.

After we have evaluated the discriminatory power of separate variables, we continue with the overall discriminatory power of the total set of variables. We will consider the goodness of a discriminant function as is reflected in the various indicators presented in Table 3. The first indicator is the eigenvalue which represents the relationship of the between group and the within group sum of squares. Higher eigenvalues can be associated with a more discriminating function. In this case the function seems to have considerable discriminating power (1.292). Another important statistic is the canonical correlation (Can. Cor.) representing the proportion of total variance that is accounted for by differences among block members and non-block members. A chi-square value of 159.695 (0.000***) and a low Wilks' lambda value of 0.436 (0.000***) imply that the hypothesis that mean scores between block members and non-block members are equal can be rejected. According to these statistics, the function has a strong discriminating power and indicates that alliance block members and non-block members do diverge with respect to a number of variables.

INSERT TABLE 3 AROUND HERE

The effectiveness of the discriminant function is measured by classifying all cases according to their score (Table 4). Table 4 represents the classification results of the originally grouped cases. We see that 88.4% of the cases are correctly classified (7), which indicates this percentage of the cases is correctly assigned to each of the groups (alliance block members vs. non-block members) based on the discriminant analysis.

INSERT TABLE 4 AROUND HERE

CONCLUSION

In this note we have explored whether technology alliance blocks are 'open' in the sense that firms with various different characteristics and backgrounds can participate, or whether these groups are carefully crafted groups composed of relatively similar firms. Our findings clearly indicate that alliance blocks are composed of firms that have attractive and often rather comparable characteristics. The specific traits of block members and the social selection processes they employ can create a source of competitive advantage in terms of innovative capacity (a.o. Duysters, Hagedoorn and Lemmens 2004).

We found that alliance block members on average had more direct links than non-block members, which implies that they are well connected. These firms were also large in terms of their revenues. Powerful alliance block members – large firms with a central position- may favor those firms that contribute most to the innovative capabilities of the group as a whole.

Central and well-connected actors are associated with high-status actors (Leik 1992). For high-status actors it may be easier to access novel information held by outsiders, because they are perceived as high-quality partners who possess leading edge technology and have rapid access to critical information and have accumulated partnering experience (Silverman and Baum 2002). For outsiders, partnering with these better-connected central and large firms may be a way to turn the alliance-based competitive strengths to their own advantage. Hence, tying up with well-connected actors provides promising opportunities to learn new capabilities and acquire advanced know-how (Silverman and Baum 2002). However, this is often not possible.

Rather, our empirical findings suggest that the central and large firms in the group have the power to carefully compose their group on the basis of specific attributes. In this way they can preserve the distinctive innovative capacity of the group. This might imply that firms that are well-positioned to bring in new technologies and know-how are more likely to be adopted in an alliance block, whereas firms that are less attractive might end up in-between blocks or in the periphery of a network. They can preclude partners from allying with firms of competing groups in order to prevent conflicting interests or knowledge leakage. This may point at social selection processes in terms of locking-out partners that are unattractive to the group, because they harm the distinct competitive edge of the group. In that sense we can confirm our hypothesis (H1 and H2) that alliance block members can ballot on non-group members' admission to the alliance block, based on the power they derive from their size and central position in the network.

We found a disproportionate number of Asian firms to operate in alliance blocks. This could be explained by the fact that Asian firms have collectivist cultural values, which foster social capital in groups as they attach value to trust-based governance in collaborative relations. This social capital or 'guanxi' represents a strong force to reproduce dense regions of ties in order to maintain and increase the value of the inherited social capital (Park and Luo 2001). The reproduction of social capital is based on investing in trustworthy relations, which implies that firms rather repeat their existing ties and look for partners that have similar cultural values. This could imply that the alliances formed between globally operating firms in alliance blocks are still determined by country-specific alliance skills and driving forces.

Our empirical findings showed that R&D intensity was a discriminating factor between alliance block members and non-block members. This finding could point at the fact that alliance block members have a sophisticated technological base. Being part of a densely connected group based on trust-based governance gives them the possibility to deepen, exploit and stretch their technological knowledge. Then the path-dependency in their innovation process (Nelson and Winter 1982) based on local search (Stuart and Podolny 1996) gives them the possibility to become an expert in their technological domain on the basis of routinized learning. Through this ability they may be better equipped to discover the technological and commercial benefits of new technologies than their non-group counterparts. Alliance block membership can help members to manage the ambiguity related to swiftly changing technological environments, as multiple alliances are a vehicle to keep options open with their group of partners (Gomes-Casseres 2001). This implies that partner selection will merely be based on selecting partners that have similar competencies to attribute to this routinized learning. This may explain their superior innovative capacity in terms of patents they apply for compared to non-group members who do not have this possibility. We found empirical evidence for this: alliance block members apply for more patents their non-group counterparts. This strongly indicates that innovative firms are more likely to obtain a position in an alliance block than other firms.

From this we can conclude that particularly the R&D intensity of alliance block members stimulates them to look for partners that have similar technological competencies in order to jointly exploit their technological knowledge bases. In this way they can safeguard and contribute to the distinct innovative capacity of the group. In that sense we can say that the R&D intensity of alliance block members is the glue that holds alliances blocks together. This confirms our hypothesis 2 (H4).

In sum, we found some clear empirical indications that alliance blocks are not open systems where any firm can join. Rather, alliance blocks are carefully composed, where the large and central firms select technologically similar firms to add to the unique innovative capabilities of the group. Because of these selection mechanisms, competing for specific partners and their distinct technologies will even enforce the group-based competition in the alliance network.

NOTES

1 In this article we use the terms ‘alliance groups’ and ‘alliance blocks’ interchangeably

2 The major purpose of discriminant analysis is to predict membership in two or mutually exclusive groups from a set of predictor variables.

3 For the purpose of significance testing, predictor variables should follow multivariate normal distributions; larger overall sample sizes are thus necessary to assure robustness of the method (Tabachnick and Fidell 1996).

4 Wasserman, S. and K. Faust (1994), Social Network Analysis, Methods and Applications, Cambridge University Press, p. 270

5 Line connectivity indicates the extent to which a pair of nodes remains connected by some path (denoted as λ (*i*,*j*)), even when lines are deleted from the graph. Based on the property of line connectivity Borgatti et al. (1990) define a lambda set as follows: ‘The set of nodes *Ns*, is a lambda set if any pair of nodes in the lambda set has larger line connectivity than any pair of nodes consisting of one node from within the lambda set and a second node from outside the lambda set.’ The smaller the value of λ (*i*,*j*), the more vulnerable *i* and *j* are to being disconnected by removal of lines. The larger the value of λ (*i*,*j*), the more lines must be removed from the graph in order to leave no path between *i* and *j* (Wasserman and Faust 1994: 270).

6 Degree centrality is measured by summing the total number of actors to which a specific player is adjacent in the matrix (a). The measure is standardized by dividing a by the maximum possible number of connections n-1 (n is the number of firms). In formal terms, degree centrality of firm k is equal to:

$$C_D(k) = \sum_i \frac{a_{ik}}{n-1}$$

7 Prior chance classification is 50%; this means we have a high percentage of correct classifications

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